Automatic Beverage Making Process

(PLC & SCADA)

Prof. Pamale Vidya
(Guide)
Dept. of Instrumentation engineering
Vidyavardhini's college of engineering and technology
Mumbai, India.

Shivankar Surabhi
(Author)
Dept. of Instrumentation engineering
Vidyavardhini's college of engineering and technology
Mumbai, India.

Pal Rohit
(Author)
Dept. of Instrumentation engineering
Vidyavardhini's college of engineering and technology
Mumbai, India.

Patil Viraj
(Author)
Dept. of Instrumentation engineering
Vidyavardhini's college of engineering and technology
Mumbai, India.

Yadav Kuldeep
(Author)
Dept. of Instrumentation engineering
Vidyavardhini's college of engineering and technology
Mumbai, India.

***Abstract*— In India, small scale and mid-cap beverage industries plays a vital role to "robust growth trajectory". Due to industrialization, automatic machines play an important role for fulfilling the process immediate needs of the society. In a challenge to competitive industrial world, a system must be flexible, efficient and cost effective; automation in machines being very much essential. Automation being versatile, it brings radical development in almost every field. New beverages are increasing day by day in the market, so this project provides a method of manufacturing beverage drinks in an approach by implementation of automation using PLC & SCADA enabling beverage preparation, filling and packaging. The objective of this project is to motivate small scale beverage industries to use automation in beverage process plant. This project implementation causes low power consumption, low operating cost, less men power, accuracy along with flexibility to the system. Thus, complete process offers execution of beverage manufacturing using the principle of batch process that will help company streamline operations, maximize profits by bring products to market at affordable cost.**

***Keywords*— PLC, SCADA, Automation,Conveyor, Sensors, Valves.**

I. INTRODUCTION

Industrial Automation is utilizing Control Systems to control Industrial Machinery and Processes with reduced human intervention. The beverage industry is surpassing the global market. This project is to design and develop a sophisticated approach for manufacturing beverage using PLC & SCADA. As an introduction to automation the prototype depicts a commercial beverage preparation and filling unit which is controlled using programmable logic controller (PLC) and the whole process is monitored using supervisory control and data acquisition (SCADA) also projecting an animation which after packaging is served as a finished product on conveyor belt. In this plant process, several operations will run simultaneously with the help of PLC. Firstly, the process begins with an user input for selection of flavour (Lime or Orange) with the feed pump simultaneously pumping the ingredients to the process ingredient tank from the reservoir. Secondly, the liquid concentrate of chosen flavour is mixed with the solution in the mixing tank forming the desired drink. Lastly, filling the containers with the /beverage drink it futher moves to the packaging unit by a conveyor which operates by a conveyor motor. All of these automated processes leads to more accuracy and flexibility of the system. By designing this system, we intend to provide an HMI Interface for the hardware such that, it will provide features Batch Management Software (BMS) with SCADA giving real time analysis of each process taking place providing data of each process undertaken throughout.

II.CONCEPT MODELLING

A. Precept

- BATCH PROCESS
  It is a manufacturing process where products are finite and have homogenous masses. Here, product to be manufactured is created stage by stage to increase speed and production with accuracy.

B. Design & Development

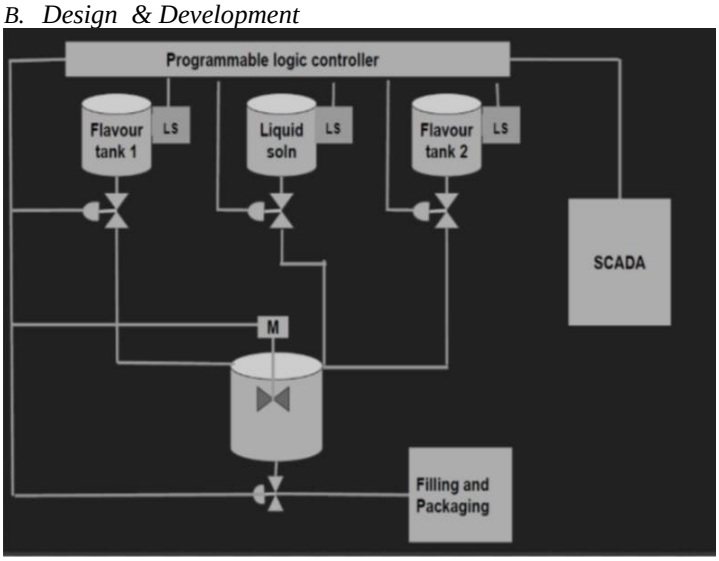

Fig2.1.Block diagram

Block functions –
Pump & control valve - filling
Motor - Mixing and operating conveyor
Level float switch- maintain levels of mixing and flavour tanks

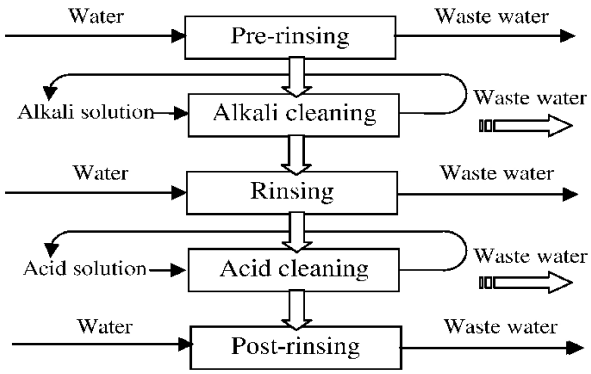

Fig2.2.CIP process

- DEMONSTRATION
  PLC & SCADA is the heart of this system.
  Fig2.1 shows the block diagram of the process.

1. The process starts with the input from the operator i.e by selecting the start button and then by choice of the flavor of beverage (Lime or Orange).
2. After selecting flavor, the valve of the reservoir tank opens and fills the solution into the mixing tank.
3. The valve of the chosen flavor tank opens and the flavor solution is added into the mixing tank.
4. On basis of timer instructions, the stirrer in the mixing tank rotates and mixes the solution with the flavor.
5. As the process of filling starts, the container placed on the conveyor is detected when in front of the filling pump by a capacitive proximity sensor.
6. Once the bottle is detected, the conveyor stops and the filling pump starts to fill the bottle based on timer instructions
7. Once the filling is done, the container is moved to packaging station via conveyor.
8. At packaging station, the preheated lids are placed on the bottle through a double acting cylinder.
9. At the end of each batch, cleaning is done by CIP method as shown in fig2.2.

III. CONTROL PHILOSOPHY

A. Programmable logic controller (PLC) -

The programmable controller opeartes where the input/output (I/O) system is physically connected to the field devices of process . The field devices like limit switches, pressure transducers, push buttons, motor or solenoids etc. can be discrete or analog I/O devices. The I/O interfaces connects the CPU with the information providers and controllable devices.

While operating, the CPU completes three processes- Initially, it reads the input data from the field devices via the input interfaces thus executing, the control program stored in the memory system and later updates the output devices via the output interfaces. This entire process of sequentially reading the inputs, executing the program in memory, and updating the outputs is known as scanning.

- PLC & related software
  Here, the PLC Allen Bradley MicroLogix1000 Analog. The software to program this PLC is RSLOGIX500 of version 7.30.10 (CPR9). Allen Bradley MicroLogix1000 Analog model of PLC, consists of 11 inputs and 8 outputs. MicroLogix1000 micro-PLC can handle a wide variety of big-time applications at 32 I/O or less which is compact full size controller.
  Communication is done through RS-232 channel allowing connectivity with personal computer enables program uploading, downloading as well as monitoring using multiple protocols, including DF1 Full-Duplex.

B. Comunication & Monitoring

- Modern SCADA system –
  SCADA stands for Supervisory Control and Data Acquisition. As the name suggests, it rather focuses on the supervisory level. The software is positioned on top of hardware to which it is interfaced, usually with PLC. The information collected is passed by SCADA, transferring it back to the central site and carry out analysis to control and then display that information on operator screens. The control actions required are then conveyed back to the process.

C. Demonstration using SCADA –

This work represents a complete application of automation. The system is controlled according to the programmed PLC and parameters are monitored using SCADA. Fig2.1 shows the SCADA view of the whole process.

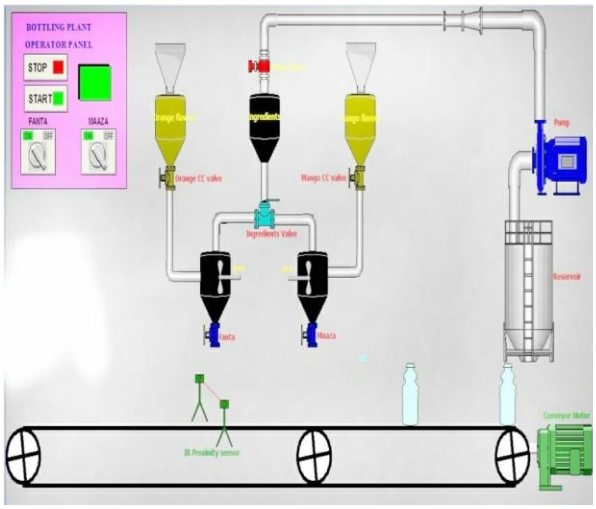

Fig. 2.1.Process monitoring SCADA screen

This is a unique design for the preparation of beverage-drinks using purified water, flavour powder, liquid concentrate. In the process when we switch ON (START) then the liquid concentrate starts to fill its respective tank. The pumps helps to fill water tank from the reservoir. By automatic opening of water valve, the water pass to the two mixing tank for a given time which was already programmed as per the tank volume and our requirement. The valve of beverage tank opens leading the concentrate liquid for the beverages to pass to their respective mixing tanks for a given amount of time. The ratio of two different liquids will decided as per the required mixed liquid that we needed in the container. Timer is set to the programmed for the valves opening and closing as per the tanks volume. A stirrer motor is fitted to mix the liquids in the mixing tank, when the mixing of the water and the concentrate liquid completed then the stirrer motor stop. Then in the next process the conveyor motor starts and the filling containers comes right below to the outlet valve of desired flavour tank valve. The position of the container is detected at the exert point by a Proximity sensor at that time conveyor motor stops and filling process starts for a given amount of time then the filling stops and conveyor motor starts. Then the containers go to the packaging unit by a by a conveyor belt. All valves controlled by timers in program. This process continues till mixing tank is empty until the batch is complete to undergo CIP. Then the whole process starts again.

IV. SYSTEM COMPONENTS

- CAPACITIVE PROXIMITY SENSOR

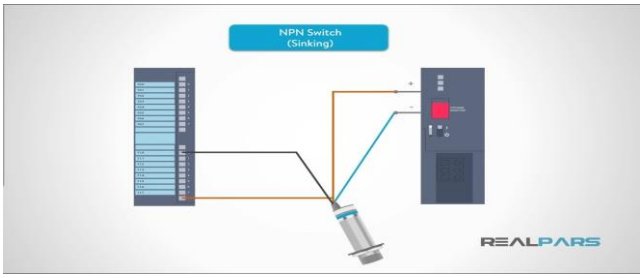

Fig.2.2. Wiring proximity sensor with PLC

Capacitive proximity sensors with PLC shown in Fig 2.2 is its connection with PLC. These are non-contact devices that can detect the presence or absence of virtually any object regardless of material. It capacitive sensor produces an electrostatic field. Here, it is used for capping and filling processes.

- PUMP

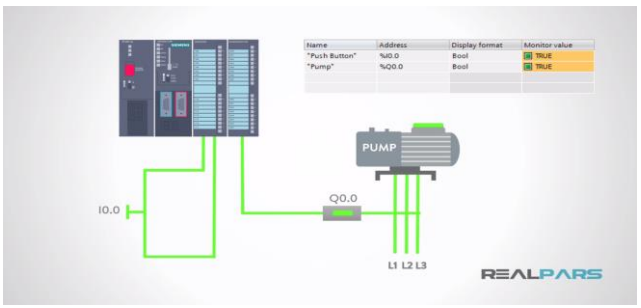

Fig.2.3. Wiring pump with PLC

Centrifugal pump shown in fig.2.3 is its connection with PLC. These pumps are special as they can provide high/very high flowrates. The flowrate varies considerably with changes in the Total Dynamic Head (TDH) of the particular piping system allowing throttling considerably with a simple valve placed into the discharge piping, with low pressure buildup in the piping and pressure relief valve operations.

- CONTROL VALVE

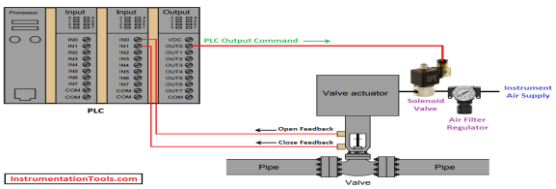

Fig.2.3.Interfacing control valve with PLC

Control valve function involves either opening or closing an orifice in a valve body, which either allows or prevents flow through the valve. Here, all the valves are timer operating programmed.

- DC MOTOR

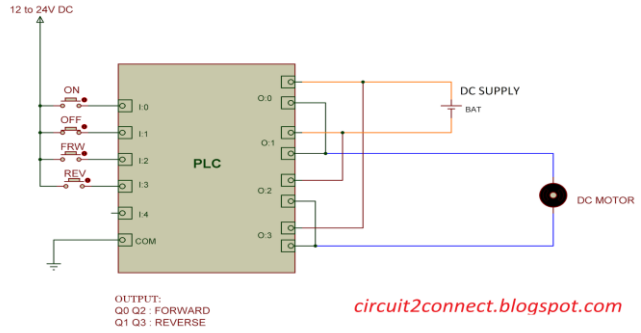

Fig.2.4. Wiring DC motor & PLC

A DC MOTOR is an electrical machine that converts electrical energy into mechanical energy. It's working says whenever a current carrying conductor is placed in a magnetic field, it will experiences a mechanical force. Here, it controls the operation of conveyor and the stirrer movement.

- FLOAT LEVEL SWITCH

Fig2.5. float level switches

Float switches are generally resting in the closed position i.e. the circuit remains incomplete so, no electricity passes through the wires. Once the water level drops below a preset point, the circuit completes to send electricity through the completed circuit triggering an alarm and vice versa. Here, used to maintain level of mixing tank and flavour tanks.

V. LADDER LOGIC

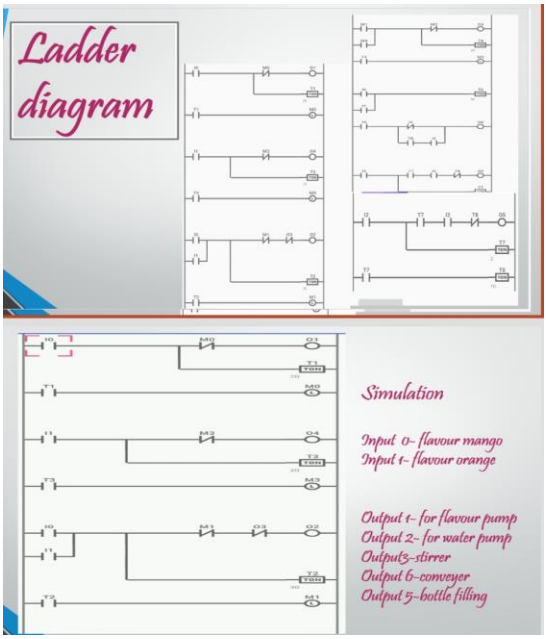

Fig.5.1.Ladder diagram

- LADDER EXPLAINATION

In a bottling plant there are two sections - Filling and packaging.
For the operation of the plant there will be 2 buttons.
The two buttons represent START and STOP.
The START button will start the whole system and the STOP button will stop the entire system. Initially the flavor pump and solution pump turns ON for a fraction of seconds and then switch OFF to turn ON the stirrer motor the conveyor belt. All the valves are timer operated valves. The proximity sensor will sense the container as it passes on the conveyer belt and hold the conveyor for seconds to complete the process of filling which future resumes onto the packaging unit completing a batch process.

CONCLUSION

This project allows small scale beverage preparation and bottling plants to introduce automation with PLC and SCADA with least human interaction and atmost accuracy and precision. Also, the system has been proved working without wastage or spilling out of the liquid. The setup for automated plant using PLC and SCADA involves high initial cost but it offers myriad advantages that overcome this cost. It leads to high production rate, using of minimum men power, saving the operational time of the plant. Additional feature of the proposed system is the use of SCADA that enables control and monitors the system even through a remote location. Hence, with this concept error detection is possible.
In mere future, this advanced technology will lead to greater efficiency of beverage production at all stages.

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REFERENCES

[1] T Kalaiselvi, R Praveena, Aakanksha R, Dhanya S. PLC Based Automatic Bottle Filling and Capping System with User Defined Volume Selection. International Journal of Emerging Technology and Advanced Engineering- 2(8)

[2] Ashwini P Somavanshi, Supriya B Asutkar, Sachin A More. Automatic Bottle Filling Using Microcontroller Volume Correction. International Journal of Engineering Research and Technology IJERT. 2013; 2(3): 1-4

[3] Shaukat N., "PLC Based Automatic Liquid Filling Process," IEEE Multi Topic Conference, 2002.

[4] SP Jain, & SL Haridas. (2014). Energy Efficient Automized Bottling Plant Using PLC and SCADA with Speed Variable Conveyor Assembly. IOSR Journal of Electronics and Communication Engineering. Vol. 9, Issue 1, pp. 9-14.

[5] LA Bryan, & EA Bryan. Programmable Controllers Theory and Implementation (2nd Ed.)